Optical Sensor Augmentation of the Coastal Ocean Monitoring & Prediction System (DURIP Project)

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LONG-TERM GOALS

The long term goal of my Ocean Optics group is to further the understanding of light in the marine environment; whether that environment be optically shallow or deep; whether it conforms to the definitions of clear, case-1 waters or is more turbid, gelbstuf, biomass, and productivity rich. We seek to improve the useful interpretation of both *in situ* measurements and above-water remote-sensing observations.

OBJECTIVES

The West Florida Shelf (WFS) has been selected by ONR and other agencies as a study site for long-term monitoring by instrumented platforms, aircraft, and ship surveys. Part of this emphasis is the Coastal Ocean Monitoring and Prediction System (COMPS) and the West Florida Shelf Initiative, a series of tower, buoys, and bottom moorings with meteorological and physical oceanographic sensors. We are extending the capabilities of the fixed COMPS platforms by including optical sensors. This will provide a continuous record of optical conditions during rapidly changing events such as storms, plankton blooms, tidal flushing, and upwelling. This information will be used as input to, or verification of, bio-optical models. The optical data will also be used to verify and explain variations in hyperspectral remote-sensing satellite imagery. By measuring inherent optical properties (IOP) and remote-sensing reflectance (R_{rs}) we hope to evaluate whether the vertical structure of bubbles, phytoplankton, or suspended sediments are affecting hyperspectral satellite imagery. Providing the data needed to develop algorithms to identify and correct the effects of such perturbations is a primary objective of this project.

APPROACH

The optical sensors will include hyperspectral remote-sensing reflectance (R_{rs} above water) and hyperspectral downwelling irradiance (E_d) for comparison to data from aircraft and the Navy's newly-developed Coastal Ocean Imaging Spectrometer (COIS) to be flown on the NEMO satellite. Robert Steward of this laboratory has been working with individuals with the University of South Florida’s (USF) Center for Ocean Technology (COT) to procure the optical and electronic components which COT is integrating into the optical sensor packages.

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WORK COMPLETED

The process of obtaining the optical and electronic equipment is continuing. The hyperspectral radiometer, line-of-sight communication link for coastal towers, power supply (solar panel, battery, controller, and enclosure), submersible pump, antifoulant chamber, transmissometers (488 and 660nm), chl. fluorometer, and Hydroscat-2 have been received and are being integrated into a sensor package. The IOP micro-controller and the master micro-controller (mass storage & networking) have been constructed and are undergoing testing by COT. The receiving station computer has been ordered and we are awaiting quotes for the diving equipment. Technical requirements are being reviewed for the buoy's GOES-satellite link, the field computer and toolkit, and the underwater bulkhead connectors and cabling.

RESULTS

The initial crucial components have been received and are being integrated into the optical sensor network. With benchtop versions of the micro-controllers operational, seawall testing of the sensor and data storage system is scheduled for the upcoming winter months.

IMPACT/APPLICATIONS

A long-term and continuous record of water-column IOP's and hyperspectral surface irradiance and reflectance measurements will be essential for the development, verification, and model-parameter adjustment of remote-sensing algorithms for the WFS. The combination of an autonomous vertical-array of IOP sensors and surface-reflectance measurements may provide the information needed to link the vertical distribution of particulates (plankton, sediments, etc.) to hyperspectral satellite imagery. The ability to make the measurements in weather unfavorable for ship-borne observation should illuminate the linkages between meteorological events and physical and optical properties of the water column.

TRANSITIONS

Ocean Color Algorithm Evaluation for Remote Sensing of Coastal and Estuarine Waters (PI: R. Stumpf, P.Testor, J.Pennock, C.Tomas, R. Arnone, and K.Carder), a NOAA-funded project, is evaluating ocean color algorithms for the use of satellite imagery of coastal and estuarine systems in the eastern Gulf of Mexico and the South Atlantic Bight. Information from the optical system will assist in the development and testing of these remote sensing algorithms.

SIMBIOS (Sensor Intercomparison and Merger for Biological and Interdisciplinary Oceanic Studies) is a NASA-funded project in which my group is examining stray light and atmospheric adjacency effects for satellite ocean-color sensors. The COMPS optical sensor network will provide a long term, continuous data set to track the surface remote-sensing reflectance.

I am also a participant in a NASA-funded project to develop high spectral resolution MODIS algorithms for ocean chlorophyll in case II waters. In anticipation of the launch of the EOS-AM 1 satellite with the Moderate resolution Imaging Spectroradiometer, this project is developing and testing algorithms to derive chlorophyll concentrations. Case II waters are composed of a complex mixture of color causing agents that can change rapidly during storms, tidal cycles, and plankton blooms. In addition, the phytoplankton pigment packaging will change diurnally due to solar exposure. The optical sensor network will record these changes and give a tremendous insight into the best application of the algorithms.

RELATED PROJECTS

ECOHAB is a multi-agency effort (EPA/NOAA/ONR) to measure and model the onset, progression, and effects of red tide blooms on the WFS. The optical sensor network will help put these data into spatial and temporal perspective, and provide a continuous record during high-energy events that would prevent ship-based sampling. The ECOHAB cruises will also provide ships-of-opportunity to maintain the optical sensors and to download higher resolution data from the buoys than would be possible to upload through the GOES network.

P.Coble and C.Castillo (USF) are investigating the hyperspectral characterization of gelbstoff for application to remote sensing of carbon cycling in coastal regions in a NASA-funded project. The continuous optical sensor records from the optical sensors will provide additional insight into the fate of CDOM, especially the effects throughout a diurnal cycle when photodegradation may take place. These investigators may from time-to-time supplement the optical sensor network with fluorescence measuring devices funded by other programs.

R.H. Weisberg and M.E. Luther (USF) are working on an ONR funded-project relating observations and Modeling of the West Florida continental shelf circulation to sediment resuspension, transport, and impacts on inherent optical properties. This collaboration between the Coastal Geology and the Ocean Optics groups at USF will add inner WFS platforms to the COMPS network. It is coordinated with other in situ measurements, satellite remote sensing, and circulation modeling programs supported by several agencies and the state of Florida. Information from the optical sensors will be vital to monitoring both the vertical and temporal structure of IOP’s on the WFS.

Similarly, a multi-disciplinary investigation of the nature and predictability of sediment resuspension in shallow water and it’s effect on water column and bottom optical properties is being undertaken by A.C. Hine, D.P. Howd, D. Mallinson, D. Naar (USF) and D. Wilson (USGS). This project on the inner WFS will study the forcing functions for particle erosion, vertical particle mixing, and sedimentation as well as the effects of these processes on the optical properties of the water column in terms of remote sensing. Again, we expect to work with these investigators to maximize the usefulness of the information gathered by the optical sensor network for verification and monitoring of the IOP’s in the shallow water environment.